The Pharma Innovation Journal 2021; 10(12): 2858-2563

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(12): 2858-2863

www.thepharmajournal.com
Received: 02-10-2021
Accepted: 09-11-2021

Sharvan Kumar Singh
Ph.D., Department of Natural Resource Management, Faculty of Agriculture Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot, Satna, Madhya Pradesh, India

HS Kushwaha
Professor, Department Agronomy, Faculty of Agriculture Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot, Satna, Madhya Pradesh, India

Rajveer Singh Yadav
Department of Natural Resource Management, Faculty of Agriculture Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot, Satna, Madhya Pradesh, India

Sanjeev Verma
Department of Natural Resource Management, Faculty of Agriculture Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot, Satna, Madhya Pradesh, India

Corresponding Author:
Sharvan Kumar Singh
Department of Natural Resource Management, Faculty of Agriculture Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot, Satna, Madhya Pradesh, India

Effect of row ratio and nutrient management practices on growth and yield of chickpea (*Cicer arietinum* L.) and mustard [*Brassica juncea* (L.) Czern. and Coss] intercropping system

Sharvan Kumar Singh, HS Kushwaha, Rajveer Singh Yadav and Sanjeev Verma

Abstract
A field experiment was conducted during rabi season of 2016-17 and 2017-18 at Mahatma Gandhi Chitrakoot Gramadaya Vishwavidyalaya, Chitrakoot, Satna (M.P.) to study the effect of row ratio and nutrient management practices on growth and yield of chickpea and mustard under intercropping system. Growth characters of chickpea *viz*. plant height, dry weight/plant at 60 DAS were observed numerically higher under chickpea + mustard (4:1) while, growth characters of mustard i.e. plant height, leaves/plant, dry weight at flower initiation and at harvest were markedly higher under chickpea + mustard (6:1) during two years. The grain yield (1500 and 1686 kg/ha) and straw yield (2696 and 2750 kg/ha) of chickpea were significantly higher in 6:1 row ratio during two years. While, intercrop mustard seed (625 and 668 kg/ha) and stover yield (2218 and 2444 kg/ha) was conspicuously higher under chickpea + mustard (4:1) system. In nutrient management, dry weight/plant of chickpea was found higher in 100% N equivalent from OM while, dry weight of mustard was noted significantly more in 125% RDF to main crop followed by FYM 10 t/ha + 75% RDF during two consecutive years. Application of FYM 10 t/ha + 75% RDF to main crop produced higher grain yield of chickpea while, straw yield was found more in 125% RDF to main crop. Mustard seed and straw yield was obtained markedly higher in 100% N equivalent to main crop from OM. Sole chickpea or sole mustard recorded higher dry weight of chickpea and mustard compared to treatment means, respectively. Pure and intercrop chickpea seed and straw yield was statistically at par during two years but it was decreased grain yield to the tune of 179.8 and 110.87 kg/ha over pure chickpea during two respective years. Significant highest chickpea equivalent grain yield (1827 and 2021 kg/ha) and LER (1.21 and 1.31) was recorded under 6:1 row ratio. In nutrient management, the highest chickpea equivalent grain yield (1866 and 2016 kg/ha) and LER (1.23 and 1.30) were obtained under FYM @ 10 t/ha + 75% RDF. Chickpea equivalent grain yield and LER were found markedly higher in intercrop than either sole chickpea or sole mustard.

Keywords: Chickpea, chickpea equivalent grain yield, growth, inter cropping system, LER, mustard, nutrient management, row ratio, Yield

Introduction
Chickpea (*Cicer arietinum* L.) is a prime grain legume crop grown during winter season in India. It is a rich in dietary fibre besides having ability to fixing atmospheric nitrogen through root nodules via interaction with rhizobia. Chickpea helps to improve soil properties by virtue of their deep root system and leaf fall. Productivity of chickpea is low and highly unstable owing to biotic and abiotic stresses in India. But at the same time, it can be rectified using proper nutrient management and adaption of agronomic practices. Chickpea + mustard is a prominent intercropping system in Indian sub continent particularly under resource constraints conditions. The important agronomic aspects in chickpea + mustard cropping are suitable row ratio, compatible varieties, appropriate sowing time and nutrient management for both the component crops. The production and profitability of mustard + chickpea intercropping may increase through the appropriate row ratio and use of optimum dose of fertilizers etc. There is no appropriate row ratio of chickpea + mustard for area specific which is varies under rainfed and dryland condition.

Nutrient management in chickpea is found to exert a great influence not only on growth and yield attributes but also sustained productivity. Higher dose of nutrients may be helpful in improving yield. Nitrogen forms an essential constituent of proteins and chlorophyll whereas phosphorus is an essential constituent of membrane system of cell chloroplast and

mitochondria, stimulating root growth and development. Potassium increases vigour and disease resistance to plants and impart winter hardiness to legume and other crops. Singh *et al.* (2019) [16] observed that sole crop of chickpea, being statistically at par with chickpea + mustard intercropping row ratio of 6:1 and 4:1 while, maximum chickpea equivalent yield was recorded under treatment combination of 4:1 (4 row of chickpea + 1 row mustard) with 125% RDF. Keeping in view the above facts the present investigation was planned to study the effect of row ratio and nutrient management practices on growth and yield of chickpea and mustard under intercropping system.

Materials and Methods

The present field experiment was conducted during *rabi* season of 2016-17 and 2017-18 at Agriculture farm of the Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya Chitrakoot, Satna (M.P.). The soil of experimental plot was sandy loam with neutral pH (7.50 and 7.40), normal EC (0.19 and 0.21 dSm^{-1}), high to low organic carbon (0.56 and 0.43%), low in available N (210 and 172 kg N/ha), High in available P (32.30 and 26.8 kg P/ha.) and medium in available K (243.6 and 191.5 kg/ha) during two consecutive years. The rainfall received during two crops growing from 56 mm and 0.0 mm, respectively. Treatment consisted two inter cropping system *viz*. chickpea + mustard (4:1) and chickpea + mustard (6:1) and five nutrient management practices (N_1: 100% RDF to main crop, N_2: 125% RDF to main crop, N_3: FYM@ 10 t/ha + 50% RDF to main crop, N_4: FYM @ 10 t/ha + 75% RDF to main crop and N_5: 100% N equivalent to main crop from organic manure. Two additional treatments of sole chickpea and sole mustard were included. Thus 12 treatment combinations (5x2 + 2) were tried in a three replicated randomized block design. Chickpea variety JG 16 and mustard variety Pusa Mahak were sown on October 25, 2016 and November 04, 2017 during two respective years. In intercropping (4:1 row ratio) four rows of chickpea were sown at 30 cm apart and in every fifth row mustard seeds were sown while in chickpea + mustard (6:1), six rows of chickpea seed were sown at 30 cm row spacing and in every seventh row, mustard seed was sown. Sole chickpea was sown at row spacing of 30 cm and sole mustard at 45 cm row spacing. Recommended dose of nutrients were applied in sole chickpea RDF to 20 kg N + 60 kg P_2O_5 + 20 kg k_2O/ha and sole mustard RDF to 80 kg N + 40 kg P_2O_5 + 30 kg k_2O/ha treatments. Intercropping treatments were provided with nutrients as per the treatment specifications. Harvesting of sole and intercropped mustard were done on March 05, 2017 and March 07, 2018 while, sole and intercropped chickpea harvested on March 15, 2017 and March 18, 2018 during two respective year. Growth and yield were recorded as per standard procedure. Land equivalent ratio (LER) was estimated as per given by Willey and Osiru (1972) [19]. The chickpea equivalent grain yield were calculated with the help of following formula.

Chickpea equivalent grain yield (kg/ha) =

$$\frac{\text{Seed yiled of mustard } \left(\frac{\text{kg}}{\text{ha}}\right) \times \text{Sale price } \left(\frac{₹}{\text{kg}}\right)}{\text{Sale price of chickpea grain } \left(\frac{₹}{\text{kg}}\right)}$$

The experimental data was statistically analyzed as per the method suggested by Gomez and Gomez (1984). The significance of the treatment effect was determined by using "F'' test. To determine the significance of differences between the means of two treatments, the critical differences (CD) was computed at 5% probability levels.

Results and Discussion

Effect on chickpea

Growth parameters

Growth parameters of chickpea *viz* plant height, dry weight/plant were not significantly influenced either by row ratio or nutrient management. Although treatment I_1: Chickpea + Mustard (4:1) had numerically taller plant and conspicuously higher dry weight/plant than I_2: Chickpea + Mustard (6:1) during 2016-17 and 2017-18, respectively except 2017-18 in plant height which numerically more lengthy plants were noted in chickpea + mustard (6:1). The greater values of these growth parameters under chickpea + mustard (6:1) was owing to less shading effect of mustard on chickpea and least affected photosynthetic activities of plants: Similar growth parameters of chickpea in chickpea + mustard in 4:1 and 6:1 was reported by Singh *et al.* (2019), Singh and Rana (2006) and Lal *et al.* (2014) [16, 15, 8].

In nutrient management treatments, plant height also showed maximum plant height (39.02 cm and 52.17 cm) in treatment N_1 100% RDF to main crop followed by N_4 FYM t/ha + 75% RDF to main crop during 2016-17 and 2017-18, respectively. Such increases in growth parameters of chickpea crop was owing to sufficient nutrients supplied in all nutrient management treatment. The significant maximum dry weight/plant at harvest under N_2: 125% RDF might be due to increase level of fertilizer which enhanced photosynthetic rates and translocation of photosynthate to different part of the plants. These results are in line of the findings of Singh and Kushwaha (2003) and Singh and Rana (2006) [13, 15].

Intercrop chickpea recorded conspicuously more plant height in 2016-17 and greater dry weight/plant during both the year than sole chickpea, while, contrary to the above in 2017-18, sole chickpea was noted numerically higher plant height than intercrop. It might be owing to efficient utilization of natural resources *viz*. water, nutrient and solar radiation etc. This finding is in conformity with the results of Singh and Rana (2006), Lal *et al.* (2014) and Singh *et al.* (2019) [15, 8, 16].

Yield

The grain yield of chickpea was recorded significantly superior (1500 and 1686 kg/ha) in chickpea + mustard (6:1) which was 353 and 406 kg/ha more than 4:1. It might be owing to numerically more plant population of chickpea, least competition by mustard for light, space, moisture and shading effect. The higher yield attributes *viz*. pods/plant and seed weight/plant was in favour of grain yield. The result of this investigation was also get supported from those obtained by Kumar and Nandan (2007), Kumar and Singh (2006), Ahlawat *et al.* (2005) and Singh *et al.* (2019) [7, 6, 2 19]. Straw yield was statistically on par in two years. Treatment I_2: chickpea + mustard (6:1) enhanced straw yield by 160 and 154 kg/ha during two years, respectively.

Nutrient management treatment enhanced grain yield significantly during 2016-17 while, in 2017-18, all nutrient management treatments produced at par grain yield. In first year treatment N_4: FYM @ 10t/ha + 75% RDF to main crop obtained significantly more grain yield than N_2: 125% RDF to main crop and N_3: FYM @ 10 t/ha + 50% RDF to main crop. Almost similar trend was found in second year. The maximum straw yield of chickpea was found in N_2: 125%

RDF (3055 kg/ha) followed by N_1 (2887 kg/ha). It might be due to recommended dose of nutrients (100% RDF), which was sufficient for growth, development and yield of crop. Improvement to grain and straw yield with increasing RDF was mainly attributed to significant enhancement in yield attributes owing to sufficient supply of available nutrients to crop. Tripathi *et al.* (2005), Abraham *et al.* (2011), Singh *et al.* (2019) [18, 1, 19] were also reported the similar results.

The superior grain yield (1561.83 kg/ha), was noted in sole chickpea. Sole chickpea produced greater grain yield by a margin of 179.80 kg (13.32%) and 11.87 kg (7.48%) during two years, respectively. The improvement on grain yield was also contributed to the yield attributes *viz*. seed weight/plant of chickpea as well as numerically higher population in pure chickpea. the results of this investigation also get supported from those obtained by Kumar and Nandan (2007), Ahlawat (2005), Tripathi *et al.* (2005), Kumar and Singh (2006), Lal *et al.* (2014) and Singh *et al.* (2019) [7, 2, 18, 8, 19].

Table 1: Effect of intercropping system and nutrient management practices on growth parameters of chickpea

Treatment	Plant height (cm)		Dry weight/plant (g) at 60 DAS	
	2016-17	2017-18	2016-17	2017-18
Intercropping System				
I_1: Chickpea+mustard (4:1)	35.37	42.67	4.311	4.752
I_2: Chickpea+mustard (6:1)	32.12	50.07	2.38	2.78
S.Em±	1.62	2.14	1.25	1.36
CD (P=0.05)	NS	NS	NS	NS
Nutrient Management				
N_1: 100% RDF to MC	39.02	52.17	2.87	3.26
N_2: 125% RDF to MC	28.58	44.83	1.99	2.40
N_3: FYM 10 t/ha + 50% RDF	32.08	43.83	2.33	2.77
N_4: FYM 10 t/ha + 75% RDF	36.32	49.00	3.28	3.50
N_5: 100% N equivalent from OM	32.73	42.00	6.25	6.90
S.Em±	2.56	3.38	1.98	2.15
CD (P=0.05)	NS	NS	NS	NS
Control V/s Treatment				
Sole Chickpea	26.40	48.00	1.93	2.29
Treatment mean	33.75	46.37	3.34	3.77
S.Em±	1.84	0.41	0.35	0.37
CD (P=0.05)	NS	NS	NS	NS

Table 2: Effect of intercropping system and nutrient management on growth parameters of mustard

Treatment	Plant height (cm)		No. of leaves / plant		Dry weight / plant (g) at flower initiation		Dry weight / plant (g) at harvest	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Intercropping System								
I_1: Chickpea+mustard (4:1)	104.0	110.4	17.4	19.5	13.2	13.4	32.4	33.2
I_2: Chickpea+mustard (6:1)	105.5	112.6	17.1	19.7	14.2	14.4	35.3	35.8
S.Em±	3.39	4.02	0.99	1.40	0.27	0.27	0.59	0.68
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Nutrient Management								
N_1: 100% RDF to MC	116.1	123.8	16.1	18.0	13.6	13.8	34.1	34.4
N_2: 125% RDF to MC	100.5	108.1	18.8	20.6	14.6	14.8	36.5	36.9
N_3: FYM 10 t/ha + 50% RDF	104.0	113.8	20.0	23.5	13.5	13.7	32.9	34.1
N_4: FYM 10 t/ha + 75% RDF	100.1	103.6	17.8	21.0	14.2	14.5	34.5	35.7
N_5: 100% N equivalent from OM	103.0	108.0	13.5	15.0	12.6	12.7	31.4	31.7
S.Em±	5.36	6.36	1.56	2.21	0.43	0.43	0.94	1.8
CD (P=0.05)	NS	NS	NS	NS	1.27	1.29	2.79	3.2
Control V/s Treatment								
Sole Mustard	95.3	99.3	23.0	24.7	12.8	12.9	32.0	32.4
Treatment mean	104.8	111.5	17.3	19.6	13.7	13.	33.8	34.5
S.Em±	2.36	3.04	1.43	1.26	0.22	0.23	0.47	0.53
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Table 3: Effect of intercropping system and nutrient management on yield of chickpea and mustard

Treatment	Chickpea				Mustard			
	Grain yield (kg/ha)		Straw yield kg/ha)		Seed yield kg/ha)		Straw yield kg/ha)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Intercropping								
I_1:Chickpea+mustard (4:1)	1200	1280	2536	2596	628	668	2218	2444
I_2: Chickpea+mustard (6:1)	1500	1686	2696	2750	546	557	1707	1730
S.Em±	48.28	73.07	163.94	216.55	32.01	41.14	216.55	268.86
CD (P=0.05)	142.43	215.56	NS	NS	N.S.	N.S.	NS	NS
Nutrient Management								
N_1: 100% RDF to MC	1413	1517.00	2806	2967	518	545	1721	1719
N_2: 125% RDF to MC	1203	1390.20	3023	3086	562	593	2123	2177
N_3: FYM 10 t/ha + 50% RDF	1205	1367.30	2452	2488	648	650	2010	2244
N_4: FYM 10 t/ha + 75% RDF	1546	1668.00	2409	2315	533	579	1799	1988
N_5: 100% N equivalent from OM	1323	1473.20	2388	2510	674	698	2159	2306
S.Em ±	76.34	115.54	259.21	342.40	50.60	65.04	342.39	425.11
CD (P = 0.05)	225.21	N.S.	NS	NS	N.S.	N.S.	NS	NS
Control V/s Treatment								
Sole Chickpea	1529.67	1594.00	2425	3215	2293	2273	6313	6164
Intercropped mean	1349.87	1483.13	2616	2673	587	613	1962	2087
S.Em ±	63.57	39.20	62.49	191.71	603.17	587.12	1538.30	1441.66
C D (P = 0.05)	N.S.	N.S.	NS	NS	1179.37	1147.98	3007.78	2818.83

Table 4: Effect of intercropping system and nutrient management on Chickpea equivalent grain yield and LER of mustard+ Chickpea system

Treatment	Chickpea equivalent grain yield (kg/ha)		LER	
	2016-17	2017-18	2016-17	2017-18
Intercropping				
I_1:Chickpea+mustard (4:1)	1577	1681	1.05	1.11
I_2: Chickpea+mustard (6:1)	1827	2021	1.21	1.31
S.Em±	60.75	83.62	0.04	0.05
CD (P=0.05)	179.23	246.68	0.12	0.16
Nutrient Management				
N_1: 100% RDF to MC	1724	1844	1.14	1.19
N_2: 125% RDF to MC	1600	1746	1.06	1.15
N_3: FYM 10 t/ha + 50% RDF	1594	1758	1.06	1.16
N_4: FYM 10 t/ha + 75% RDF	1866	2016	1.25	1.30
N_5: 100% N equivalent from OM	1727	1892	1.15	1.26
S.Em ±	96.77	132.22	0.07	0.08
CD (P = 0.05)	N.S.	N.S.	N.S.	N.S.
Control V/s Treatment				
Sole Chickpea	1530	1594	1.00	1.00
Sole Mustard	1376	1364	1.00	1.00
Intercropped mean	1702	1851	1.13	1.21
S.Em ±	60.75	90.38	0.05	0.07
C D (P = 0.05)	NS	NS	NS	NS

Effect on mustard

Growth parameters

Growth character *viz*. plant height, leaves/plant and dry weight/plant of mustard did not show significant variation under 4:1 and 6:1 row ratio of chickpea + mustard intercropping system. Although, chickpea + mustard (6:1) system produced markedly higher plant height and leaves/plant, than chickpea + mustard (4:1) system during 2016-17 and 2017-18 except leaves/plant at 2016-17 which had observed reverse trend. At flower initiation, chickpea + mustard (6:1) produced significantly higher (14.22 g and 14.38 g dry weight/plant) in mustard crop during both the years, respectively, however, at harvest stage, it had produced numerically higher by a margin of 2.95 and 2.60 g/plant under chickpea + mustard (6:1) over chickpea + mustard (4:1) in two years respectively. Similar growth characters in two systems were possible owing to sufficient space available for development of mustard and neutral effect of chickpea on growth of mustard in two systems. In 6:1 ratio, mustard avail more space for spreading hence numerical improvement was obvious. Singh *et al.* (2019) [19] reported equal plant height and branches/plant of mustard in 4:1 and 6:1 row combinations of chickpea + mustard.

In nutrient management, statistically similar plant height and leaves/plant of mustard plant were noted in all nutrient management treatment (Table 2). However, greater plant height (120.00 cm) were noted in N_1: 100% RDF and leaves/plant (21.75) in N_3: FYM@ 10t/ha + 50% RDF. Significantly superior dry weight / plant (14.700 g) was observed in N_2: 125% RDF followed by N_4: FYM@ 10t/ha + 75% RDF (14.328 g) at flower initiation and 36.690 g/plant in N_2: 125% RDF to main crop at harvest stage of mustard. The similar growth parameter of mustard was owing to 100% RDF was sufficient to growth and development of intercropped mustard. Singh and Verma (1997) and Singh and Sing (1998) [14, 12] reported numerical enhancement of growth characters over 100% RDF.

When pure system compared to intercrop, growth characters

of mustard *viz*. plant height, leaves/plant were almost equal in pure and intercropping of mustard but the greater plant height (108.13 cm) and leaves number (23.83/plant) were noted in sole cropping of mustard. The dry weights/plant recorded at flower initiation and at harvest were at par in pure and intercropped mustard but the highest dry weight (13.78 g and 34.20 g in respective stages) were found in intercropped mustard. In intercropping system, mustard availed much space for spreading of plant, and plant have plasticity thus numerically better growth parameters were noted in intercropping system of mustard. The results are corroborated with the findings at Lal *et al.* (2014), Tripathi *et al.* (2005) and Prasad *et al.* (2006) [8, 18, 11].

Yield

Seed and stover yield of intercropped mustard was statistically at par in system of chickpea + mustard in 4:1 and 6:1 row ratio during two years. Chickpea + mustard (4:1) increased seed yield of mustard by a margin of 82 kg/ha or 15.01% and 111 and 19.92% over chickpea + mustard (6:1), respectively. Stover yield was increased by 511 kg or 23.04% and 714 kg or 29.21% under chickpea + mustard (4:1) over chickpea + mustard (6:1), respectively in two years. This was owing to higher plant population of mustard (In 4:1, mustard population 30% and in 6:1, 20% to that of 100% in pure mustard). The results are confirmed with the findings supported by Tripathi *et al.* (2005), Ahlawat *et al.* (2005), Kumar and Singh (2006) and Singh *et al.* (2019) [18, 11, 2, 19].

In nutrient management, seed yield was obtained maximum (674 and 698 kg/ha) in N_5:100% N equivalent to main crop followed by 648 and 650 kg/ha in N_3 FYM @ 10 ton/ha + 50% RDF while stover yield was highest (2159 and 2306 kg/ha) in N_5 100% N equivalent to main crop from OM followed by 2159 and 2306 kg/ha in $N_2$125% RDF. It might be owing to 100% RDF which was sufficient for growth, development and yield of intercropped mustard. Mustard may also be take residual fertility from associated chickpea crop (Legume crop) hence, 100% RDF gave more yield. Singh *et al.* (2019) stated that yield component and yield of intercropped mustard were on par with 100% and 125% RDF Abraham *et al.* (2011), Tripathi *et al.* (2005), Bohra *et al.* (1999) [1, 18, 4], reported numerical enhancement in yield under 100% RDF.

Pure mustard gave significantly higher seed yield of mustard than treatment mean of intercropping during two years. Treatment mean of intercropping gave 25.60% and 26.97% seed yield compared to that of 100% in pure mustard during both years, respectively. Singh *et al.* (2019) [19] stated that yield component and yield of intercropped mustard were on par with 100% and 125% RDF Abraham *et al.* (2011), Tripathi *et al.* (2005) and Bohra *et al.* (1999) and Singh and Singh (1998) [1, 18, 4, 12] reported numerical enhancement in yield under 100% RDF. Treatment mean of intercropped mustard produced significantly lower stover yield than pure mustard in two experimental years. It gave 1965 and 2087 kg/ha stover yield which was 68.87% to 66.14% that of 100% in pure mustard (6313 and 6164 kg/ha).

Chickpea Equivalent grain yield (CEGY)

Intercropping system, chickpea + mustard (6:1) gave significantly more CEGY than I_1: chickpea + mustard (4:1) during two years (Table 4.). Treatment I_2: Chickpea + mustard (6:1) enhanced chickpea equivalent grain yield by 250 kg/ha and 340 kg/ha during two years, respectively. This would be ascribed due to superior grain yield under chickpea + mustard (6:1). Srivastava *et al.* (2007), Tripathi *et al.* (2005) and Prasad *et al.* (2003) [17, 18, 10].

Significantly at par chickpea grain equivalent yield were obtained in all nutrient management treatment but it was highest (1866 and 2016 kg/ha) in N_4: FYM @ 10 t/ha + 75% RDF followed by N_5: 100% N equivalent to main crop (1727 and 1892 kg/ha). This might be due to higher grain yield of chickpea comparatively higher seed yield of intercrop mustard. The total increased fetched highest market price thereby increased the chickpea grain equivalent yield. These findings are in lines of those of Abraham *et al.* (2011), Srivastava *et al.* (2007), Arya *et al.* (2007) and Singh *et al.* (2019) [1, 17, 3, 16,].

Treatment of intercropping had statistically equal CEGY during two years. Pure chickpea grain yield was lower (1530 and 1594 kg/ha) than treatment mean of intercropped chickpea grain equivalent yield (1702 and 1851 kg/ha). This was owing to additional yield of intercrop mustard. Treatments mean enhanced chickpea equivalent grain yield by 172 kg or 10.11% and 257 kg or 13.88% during two years, respectively over pure chickpea. The findings were supported by Kumar and Nandan (2007), Lal *et al.* (2019) and Singh *et al.* (2019) [7, 9, 16].

Land Equivalent ratio

Chickpea + mustard (6:1) had significantly greater LER (1.21 and 1.31) during two years as compared to chickpea + mustard (4:1). Treatment chickpea + mustard (6:1) improved LER by 0.16 unit and 0.20 unit, respectively during two years over treatment I_1: chickpea + mustard (4:1) It was attributed to higher grain yield of chickpea and seed yield of mustard. The total increased yield fetched higher market price thereby increased the equivalent grain yield of chickpea. Similar results were observed in the findings of Kumar and Nandan (2007), Lal *et al.* (2019) and Singh *et al.* (2019) [7, 9, 16].

The LER (Land area equivalent ratio) did not varied significantly with nutrient management practices It was recorded highest (1.25 and 1.30) in N_4: FYM @ 10 t/ha + 75% RDF It was owing to variation in yield of component crops of respective treatment. Tripathi *et al.* (2005) and Singh *et al.* (2019) [18, 16] reported variation on LER owing to nutrient management. The higher LER value indicate the higher relative yield of two the component crops than their pure cropping.

LER was not differed significantly in pure chickpea and pure mustard but it was more under treatment mean of chickpea + mustard intercropping (1.13 and 1.21) than pure system during two respective years. It showed intercropping system has beneficial than pure chickpea / pure mustard. Singh *et al.* (2019). The higher LER value indicate the higher relative yield of two the component crops than their pure cropping. This finding is close conformity with the result of Kumar and Nandan (2007), Kumar and Singh (2006) [7, 11].

Conclusion

Thus it may be concluded that sowing of chickpea and mustard in the row ratio of 6:1 and supplemented with higher dose of nutrient (FYM 10 t/ha + 75% RDF to main crop) was performs better than sole chickpea or sole mustard crop cultivation.

References

1. Abraham J, Thenua OVS and Sharma UC. Evaluation performance sole crops on influenced by irrigation regimes and fertility gradients. Indian Journal Agriculture Science. 2011;81(8):772-775.
2. Ahlawat IPS, Gangaih B and Singh O. Production potential of chickpea (*Cicer arietinum* L.) based intercropping systems under irrigated condition. Indian Journal Agronomy. 2005;50(1):27-30.
3. Arya RL, Varshney Jay G and Kumar Lalit. Effect of Integrated nutrient application in chickpea + mustard intercropping system in the semiarid tropics of North India. Communications in Soil Science and plot Analysis. 2007;38:229-240.
4. Bohra JS, Goswami A and Sah D. Agronomic studies on gram and mustard intercropping. 10th International Rapeseed congress, Australia. 1999.
5. Gomez K and AA Gomez. Statistical procedures for agricultural research (2 Ed.). John wiley and sons, NewYork. 1984.
6. Kumar A and Singh BP. Effect of row ratio and phosphorus levels on performance of chickpea (*Cicer arietinum* L.) + Indian mustard (*Brassica juneea*) intercropping. Indian Journal of Agronomy. 2006;51(2):100-102.
7. Kumar G and Nandan R. Effect of date and pattern of planting on productivity and economics of chickpea + mustard intercropping system. Journal of Food Legumes. 2007;20(2):184-186.
8. Lal B, Rana KS, Rana DS, Gautam P, Shivay YS, Ansari MA *et al.* Influence of intercropping, moisture conservation practice and P and S levels on growth, nodulation and yield of chickpea (*Cicer arietinum* L.) under rainfed condition. Legume Research-An International Journal. 2014;37(3):300-305.
9. Lal B, Rana KS, Rana DS, Shivoy YS, Sharma DK, Meena BP and Gautam, Priyanka. Biomass yield, quality and moisture use of Brassica Carinata as influenced by intercropping with chickpea under semi and tropics. Journal of Saudi Society of Agriculture Science. 2019;18(1):61-71.
10. Prasad K, Rawat SK and Pyare Ram. Performance of mustard varieties with association of chickpea under limited irrigations Farm Science Journal. 2003;12(1):157-158.
11. Prasad Kedar, Singh RK and Pyare Ram. Studies on intercropping of mustard varities with chickpea. Indian Journal Pulses Research. 2006;19(1):73-75.
12. Singh BD and Singh BP. Effect of weed management practices and phosphorus levels on weed infestation, nodulation and yield of chickpea+ mustard intercropping system. Indian Journal of Weed Science. 1998;30(3&4): 124-128.
13. Singh SB and Kushwaha BL. Influence of sulphur and phosphorus on productivity of chickpea + mustard intercropping. Abstract (In): National symposium on pulse for crop diversification and national resource management held on Dec. 20-22, 2003 at IIPR, Kanpur. 2003, 132
14. Singh NB and Verma KK. Response of linseed to varying irrigation and fertility levels. Indian Journal of Agronomy. 1997;42(4):696-698.
15. Singh T and Rana KS. Effect of moisture conservation and fertility on Indian mustard (Brassica juncea) and lentil (*Lens culinaris*) intercropping system under rainfed conditions. Indian journal of Agronomy 2006;51(4):267-270.
16. Singh Vipul, Singh Ghanshyam, Pandey Vinay Kumar, Kumar Manoj, Singh Ajay. Performane of chickpea-mustard intercropping under different fertility management and various row combinations. International Journal of Current Microbiology and Applied Science. 2019;8(1):236-249.
17. Srivastava RK, Bohara JS and Singh RK. Yields advantage and reciprocity function of wheat + Indian mustard intercropping under varyieng row ratios, variety and fertility levels. Indian Journal of Agricultural Sciences. 2007;77(3):139-144.
18. Tripathi HN, Chand S, Tripathi AK. Growth and yield of Bengal gram (*Cicer arietinum* L.) as influenced by mustard raised as inter crop and varying levels of phosphorus. Research on Crops. 2005;6(2):205-208.
19. Willey RW and Osiru DSO. Studies on mixtures of maize and beans (*Phaseolus vulgaris*) with particular reference to plant population. Journal of Agricultural Sciences. 1972;79:517-529.